Presentation to
Land Warfare Conference 2000

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Change: The Norm, Not the Exception

Today's World **--**

Rapidly changing threat

Globalization of critical technology

Rapidly shifting rules of engagement

Increasing role of affordability in acquiring technolog

One cannot manage change . . . one must stay ahead of it with

Speed . . . Flexibility . . . Adaptability

DARPA is the *change leader* for the Department of Defense

DARPA Mission

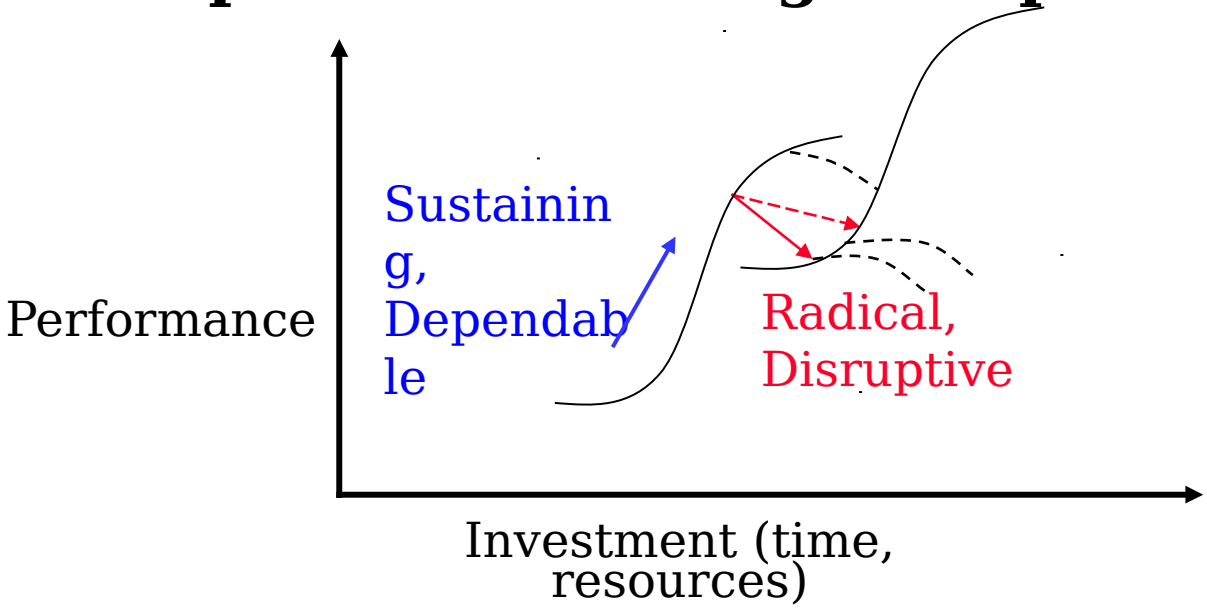
Technical Innovation in Support of National Security

- **Solve National-level problems**
- **Enable Operational Dominance**
- **High-Risk, High-Payoff Technology Development and Exploitation**

REVISED

Innovation

Innovation is more than invention -- it represents a change in operations



- **Innovation takes a long time for large institutions**
- **Radical innovation is risky; requires an iterative process**
- **Radical innovation requires leadership, dedication, protection**

DARPA's Role

DARPA		SERVICE R&D
tom-up, opportunity, event-driven	★	Top-down, requirement, schedule-dr
Great process flexibility	★	Highly formalized processes
Integrated research	★	6.1 - 6.5 research separated
Radical change	★	Reliable, sustainable gains
Central DoD agency for R&D	★	Support Service mission
Planned product obsolescence	★	Planned product improvement

The DoD requires both radical innovation and requirements-based R&D

DARPA's Approach

Strategy

- Flexibility, ability to quickly exploit emerging situations is the highest priority
- Emphasize high technical risk, high focus investments
- Emphasize competition for ideas, reward for quality performance
- An investment firm, not R&D lab, no established constituency
- Methodically search for and exploit externally generated ideas

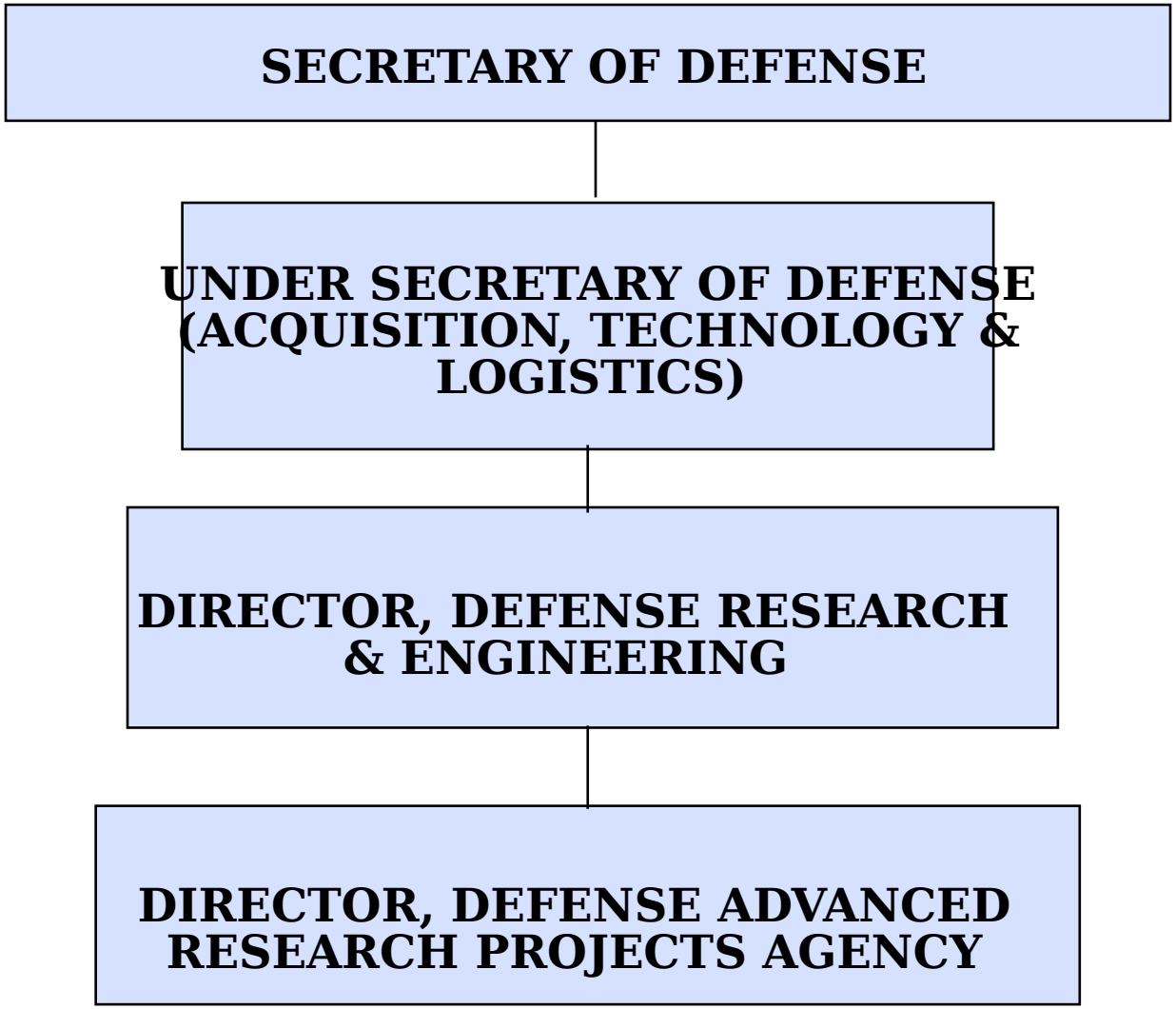
Operations

- Flat, small organization, no long-term investments in facilities, themes
- Constant rotation of programs, program managers, directors
- Continuity provided by industry, other government agencies, customer
- Highly flexible contracting, hiring capabilities

DARPA is DoD's Enabler for Radical Innovation

- Broader horizon than commercial analogues
- More focused than university research

Chain of Command


SECRETARY OF DEFENSE
UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY & LOGISTICS)
DIRECTOR, DEFENSE RESEARCH & ENGINEERING
DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Some Current Focus Areas

National-Level Problems

- Protection from Biological Attack
- Protection from Information Attack

Operational Dominance

- Affordable, Precision Moving Target Kill
  - Offensive and Defensive
- Dynamic Command & Control
  - Mobile Networks
  - Near-Real-Time Planning, Replanning
- Future Warfare Concepts
  - Hard and Deeply Buried Target Classification
  - Combined Manned, Unmanned Operations

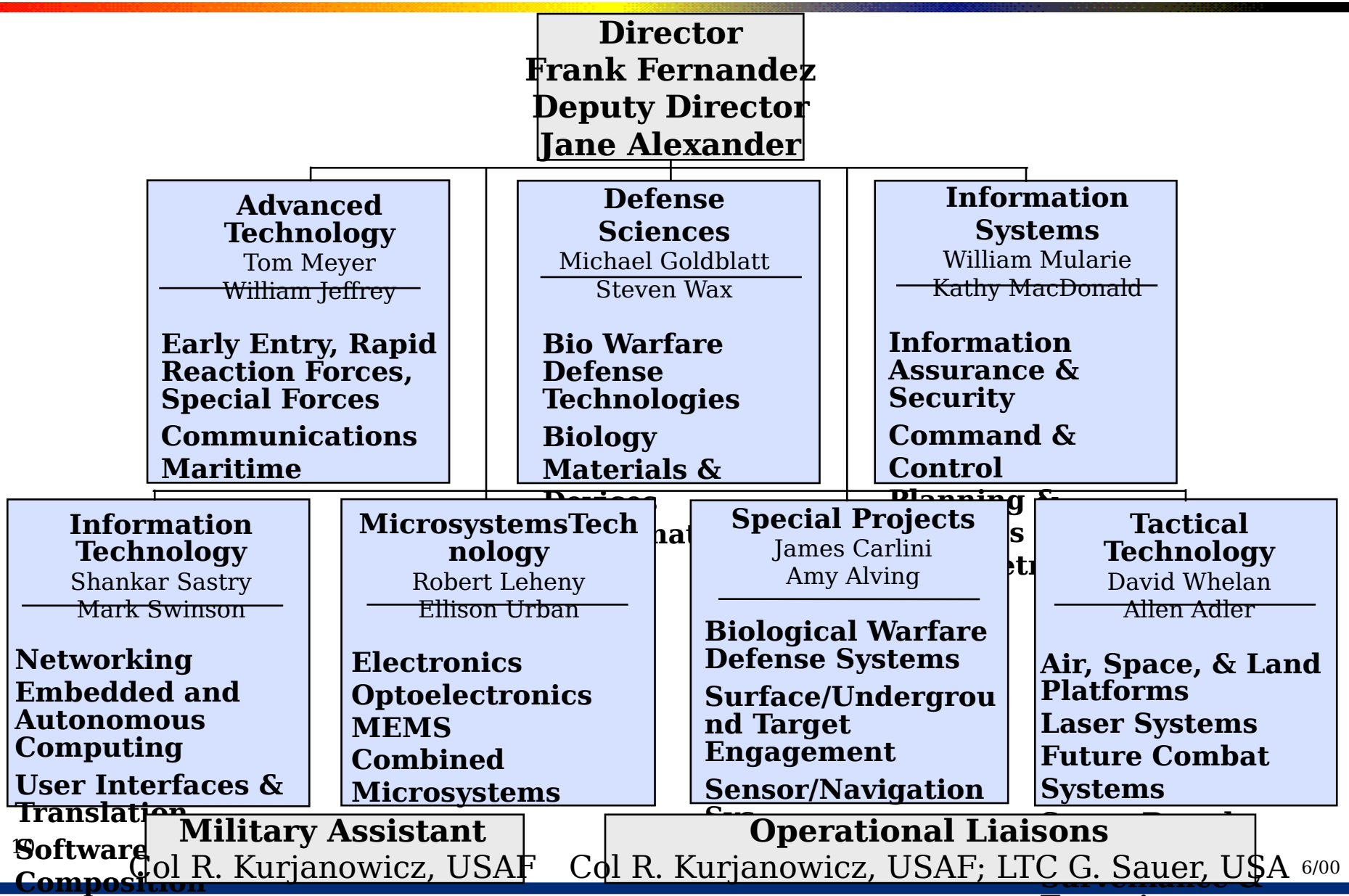
High-Risk, High-Payoff Technology Exploitation

- Information, Microsystems, Math, Materials
- Intersection of Biology, Information and Microsystems
- Beyond Silicon

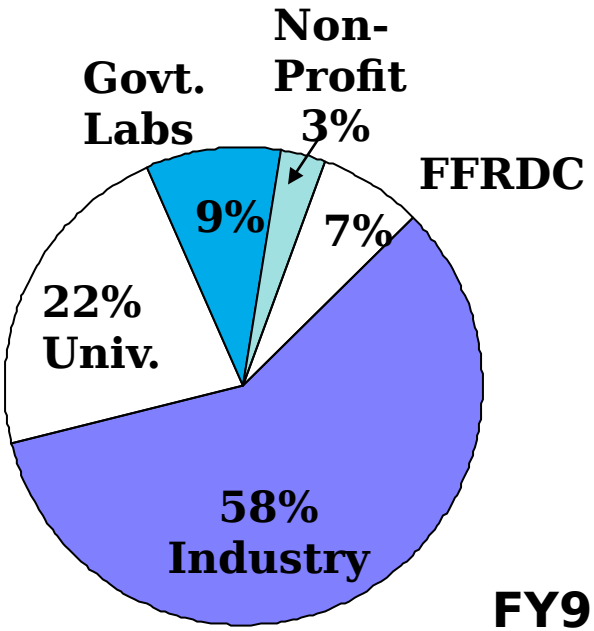
DARPA Investment Criteria

- **We constantly ask our Technical Directors/Program Managers:**
  - **What are you trying to accomplish?**
  - **How is it done now, and with what limitations?**
  - **What is truly new in your approach which will remove current limitations and improve performance? By how much?**
  - **If successful, what difference will it make?**
  - **What are the mid-term, final exams or full scale applications required to prove your hypothesis? When will they be done?**
  - **What is the DARPA "exit strategy"?**
  - **How much will it cost?**

DARPA Organization



DARPA Overview



FY99

BUDGET ($ in Millions)

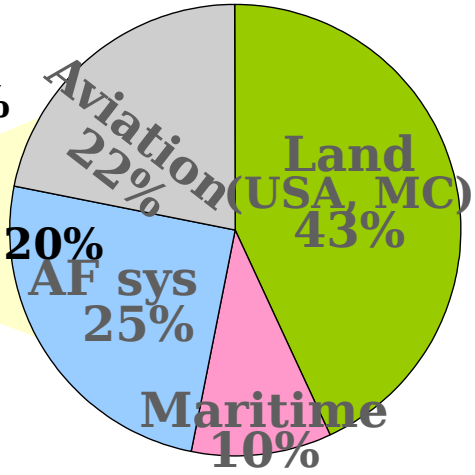
	FY99	FY00	FY01
• Basic Research	57.4	67.6	90.4
• Applied Research	900.9	941.7	1,025.6
• Adv Tech Dev	849.0	830.0	795.6
• Mgmt & Spt	80.7	37.1	39.7
TOTALS	1,888.0	1,876.4	1,951.3

WARFIGHTER SUPPORT – FY01

Nat'l Level Enabling Tech. 55%

All Services - 25%

Service-Specific – 20%

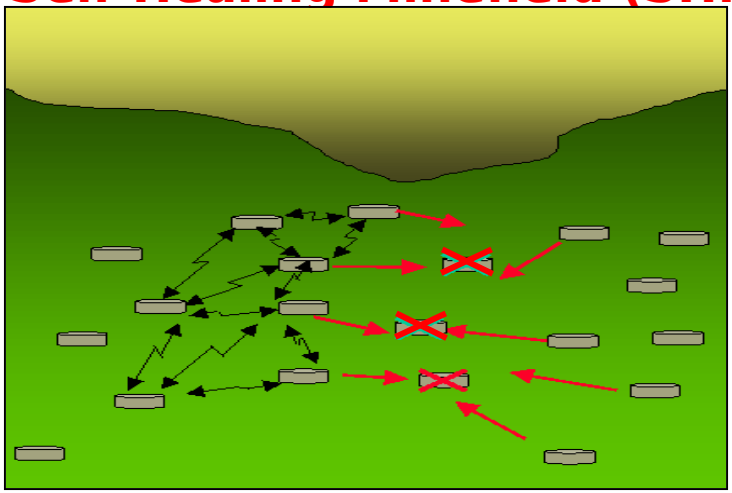


Future Land Warfare

- **DARPA Program Highlights**
  - **Self-Healing Minefield**
  - **Wolfpack**
  - **Metal Storm**
  - **SUO: SAS**
  - **Airborne Communications Node**
  - **Reconnaissance, Surveillance and Targeting Vehicle**
  - **Netfires**
  - **LADAR, A160, Micro Air Vehicle, Unmanned Ground Combat Vehicle, Autonomous Perception**
  - **Future Combat Systems (FCS)**

Self-Healing Minefield

Self-Healing Minefield (SHM)



USER PAYOFF

- **SHM provides a robust antivehicle obstacle without use of antipersonnel landmines**
- **Complicates BOTH mounted and dismounted breach**
- **Minefield acts like a fluid – Cannot sustain a breach**

DESCRIPTION

- **Minefield detects a breaching attempt through mine-to-mine communication or collective sensing**
- **Individual mines respond to breaching attempt by reorganizing/ moving to fill in the open lane. (The barrier is re-established)**
- **Minefield is an intelligent distributed network with decentralized control**

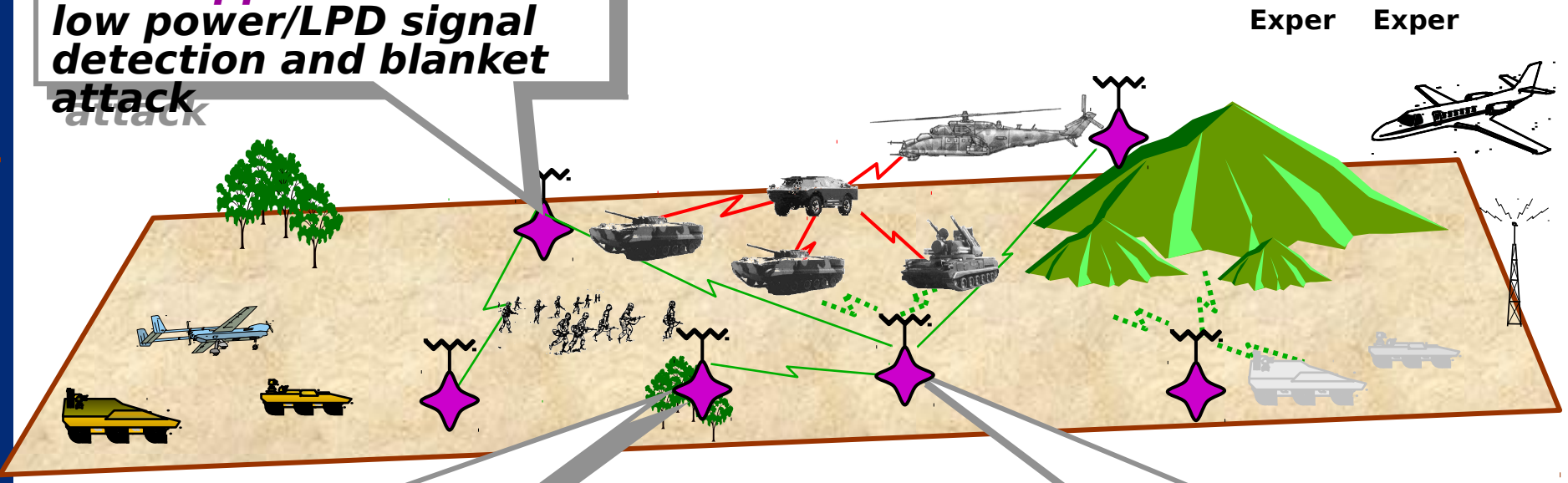
MILESTONES

- **Preliminary Analysis, FY99**
  Assess robustness against simple breaching
- **Battlefield Utility, FY99-FY02**
  Assess system performance relative to existing capabilities
- **Research Enabling Technologies, FY00-FY02**
  Mobility, Communications, Behaviors
- **Integrate and Test surrogate Minefield, FY02-FY03**
- **Transition to US ARMY, FY03**

WolfPack

Distributed Networked Electronic Warfare

***Close approach** enables low power/LPD signal detection and blanket attack*



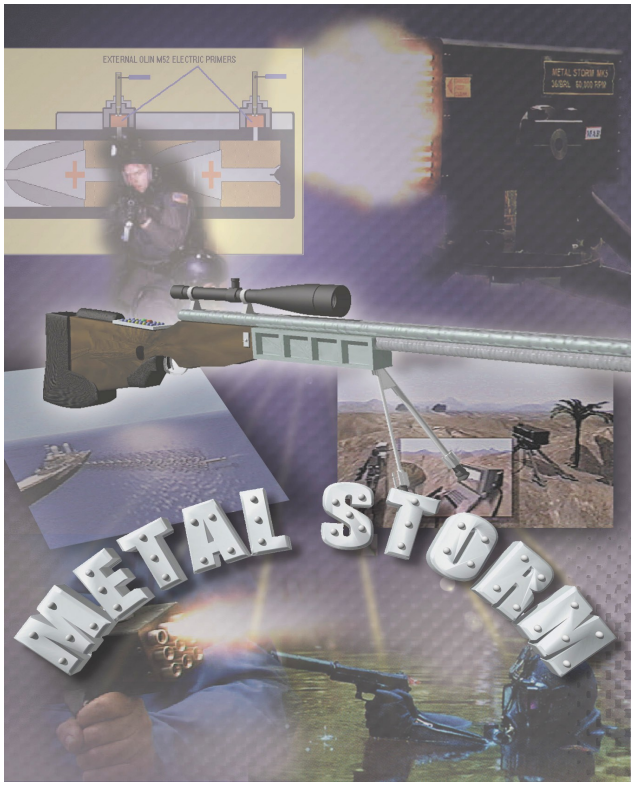
***Distributed units** enable wide area spectrum monitoring and directed attack*

***Network awareness** permits precision attack/avoidance with minimum power*

***WolfPack Technology** responds to advanced LPD/LPI, Packet Network*

Metal Storm

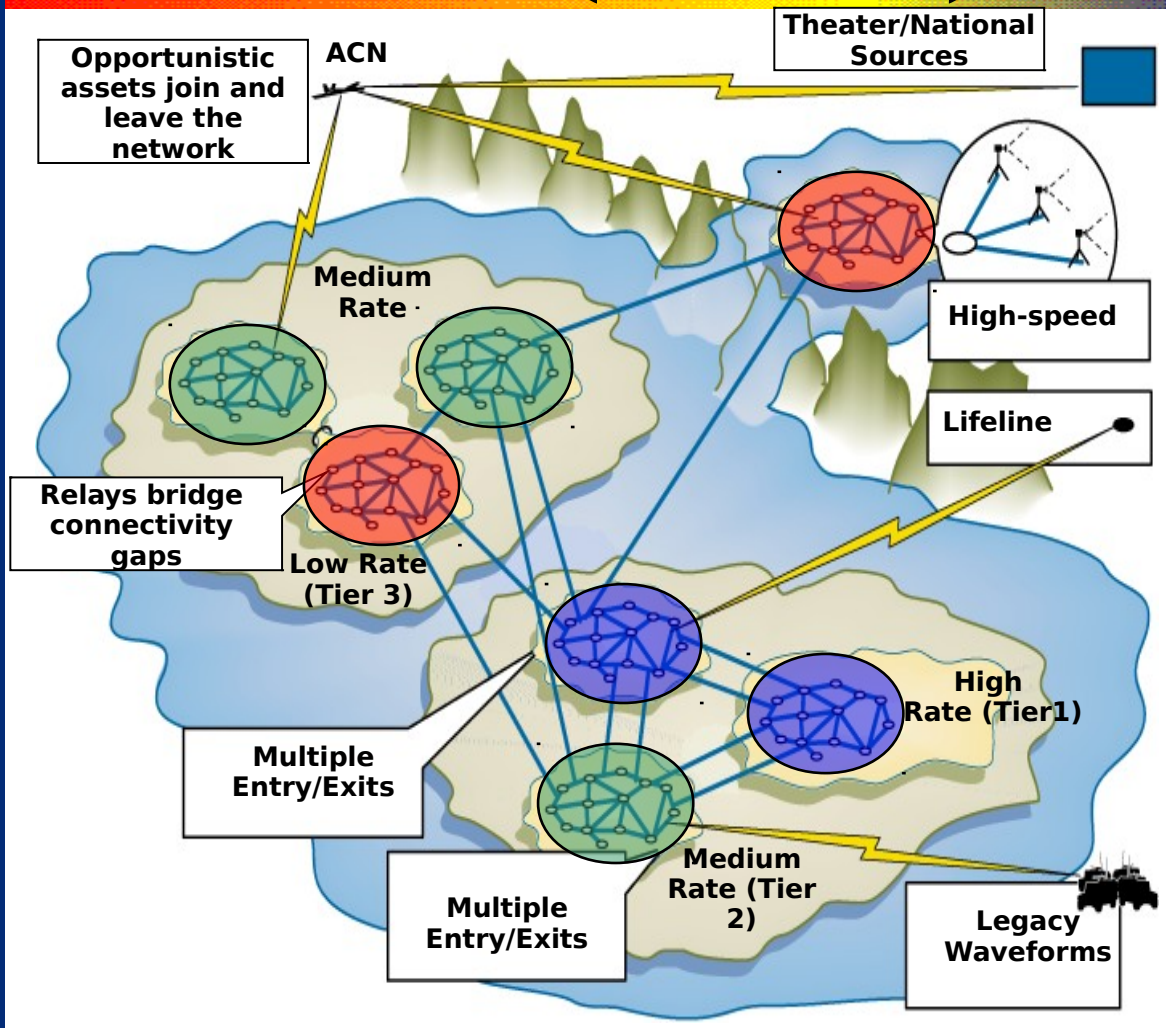
Revolutionary New Weapon Technology



- **A unique 100% solid state system. Attributes:**
  - **Fires projectiles in multiple tubes**
  - **Electronically variable sequenced rate of fire, up to 1 million rounds/min**
  - **Can be tightly packed / stored / transported**
- **Cooperative and collaborative research and development effort with Australian DSTO**

Application to a wide range of small arms and crew-served weapons for military and civilian law enforcement

Small Unit Operations: Situational Awareness Systems (SUO: SAS)

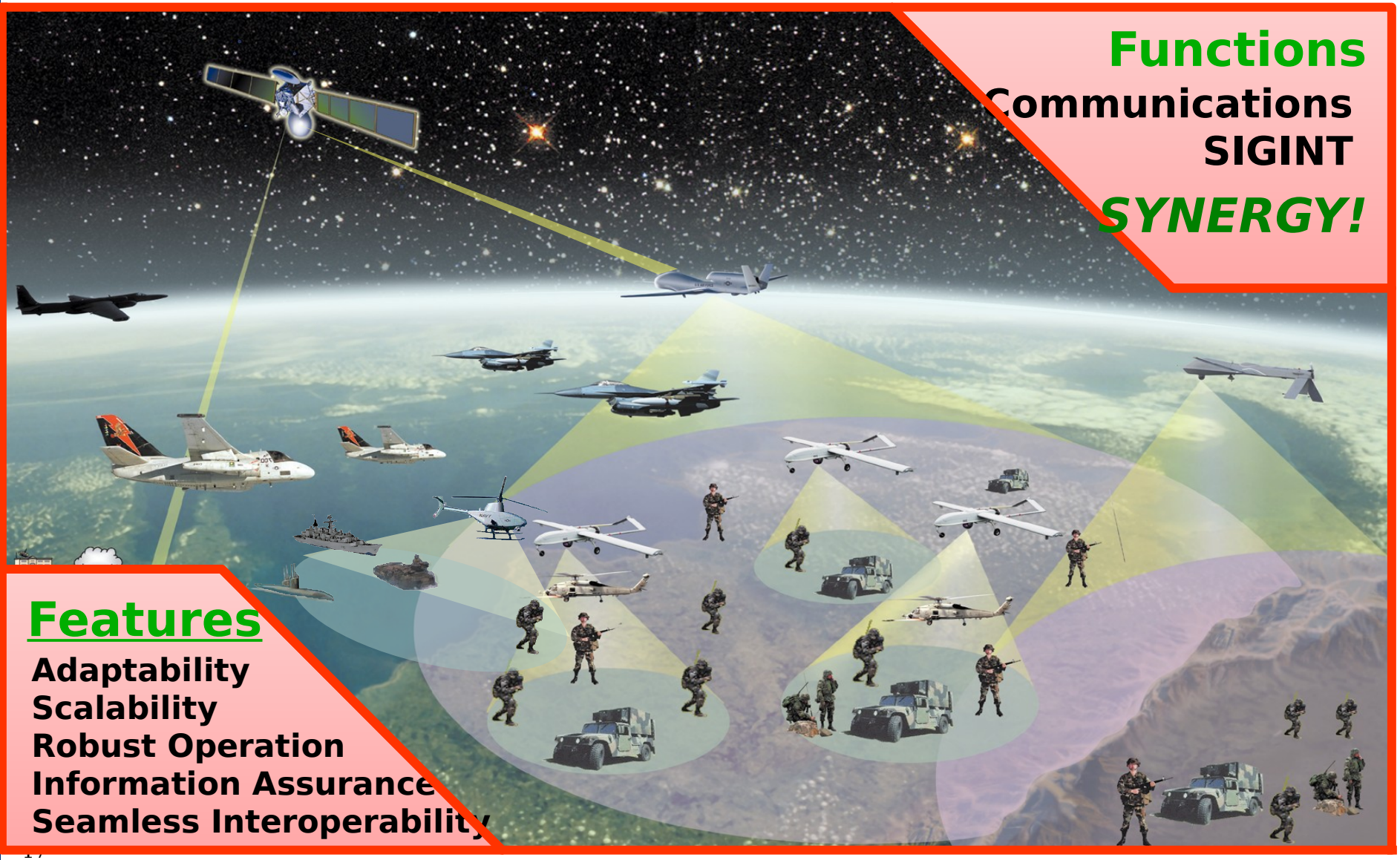


Autonomous Adaptive Networking

- **"Islands" formed based on connectivity in three tiers**
- **Tier 1 islands (blue) communicate with Tier 2 (green) and Tier 3 (red) islands through self-elected gateways**
- **Periodic discovery messages and data update routing tables to prune and heal the network**

Connectivity enabled at distances, data rates, and LPD levels not previously achieved

Airborne Communications Node (ACN)



Functions

Communications
SIGINT

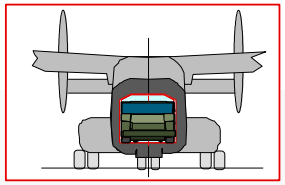
SYNERGY!

Features

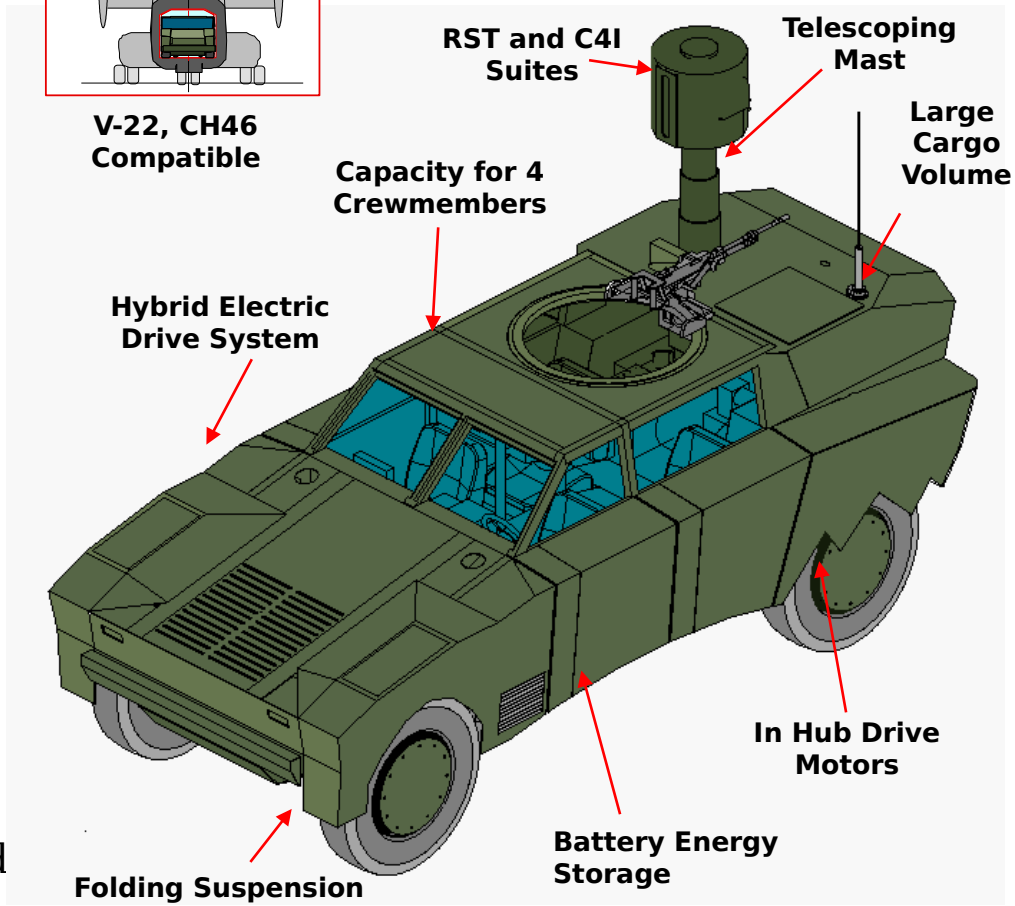
Adaptability
Scalability
Robust Operation
Information Assurance
Seamless Interoperability

Reconnaissance Surveillance Targeting Vehicle (RST-V)

- **V-22 Internal Transport**
  - Deployment Ready
  - Tactical and Deep Insertion
  - 10 Day Mission
- **Integrated Survivability**
  - Ballistic
  - AP Mine
  - Managed Signature
- **Hybrid Electric Drive**
  - Improved Fuel Economy
  - Improved Range
  - Extended Silent Movement and Silent Watch



V-22, CH46 Compatible

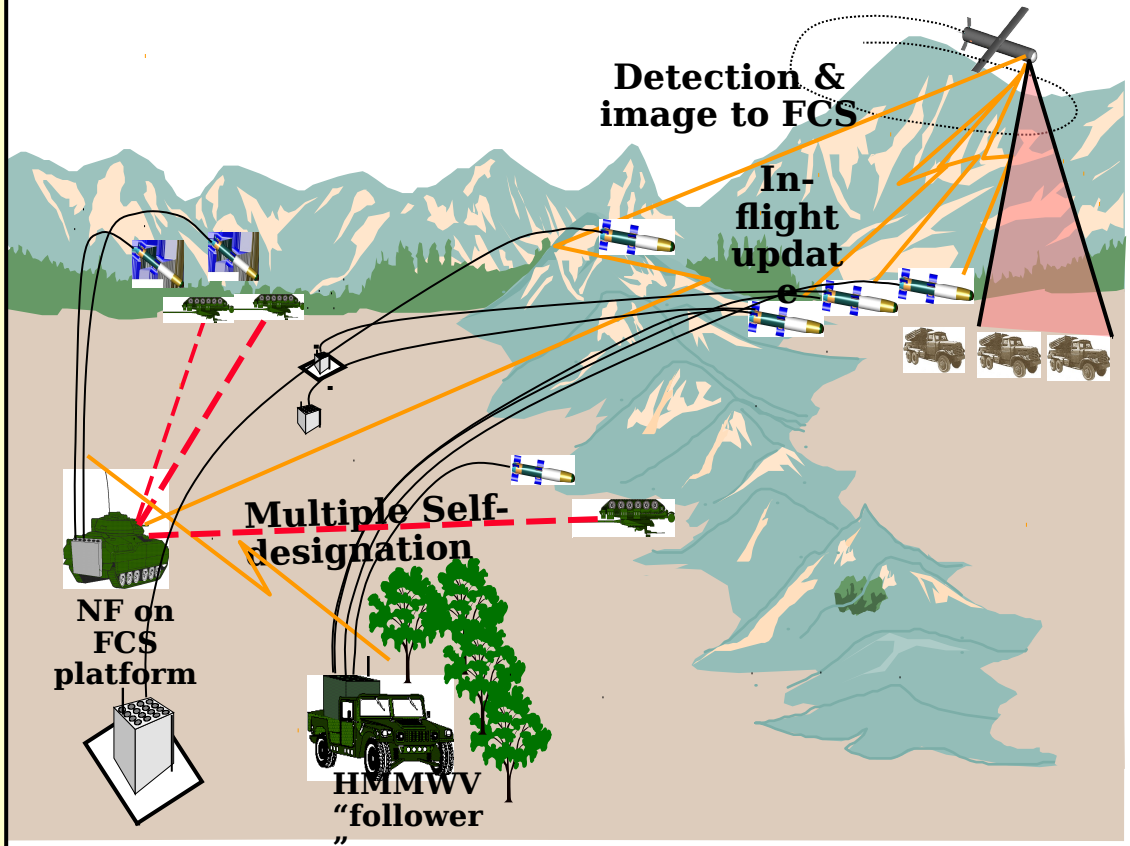


NetFires

Demonstrate two LOS/NLOS weapons

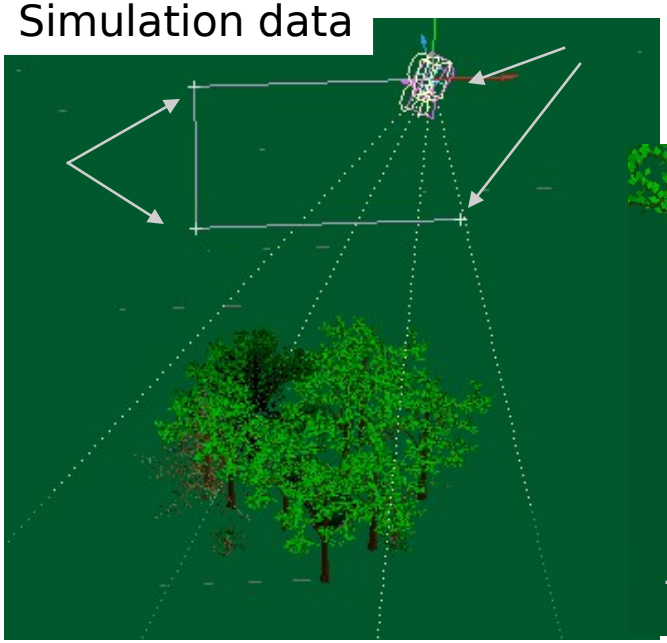
- **Rapid Response PAM**
  - **Short time of flight (100s/25km)**
  - **Multimode terminal guidance**
  - **Low cost configuration: Uncooled imaging IR seeker**
  - **Lock-on after launch**
- **Hunter Killer LAM**
  - **3-D ladar seeker w/ATR, TERCOM**
  - **Significant loiter**
  - **Multi-mission including BDA**
- **PAM/LAM**
  - **GPS/INS guidance**
  - **Variable propulsion**
  - **Terminal guidance (end game)**
  - **Midcourse update through networked 2-way data link**
- **Platform independent launcher**

"This fundamentally reengineers close combat."



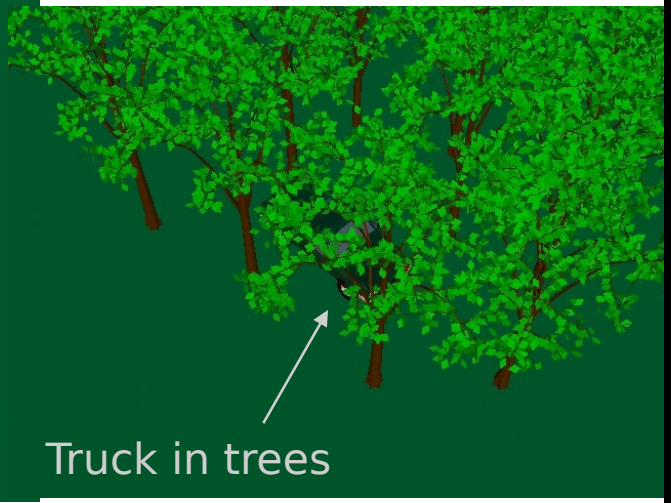
JIGSAW: LADAR sensing for Combat ID

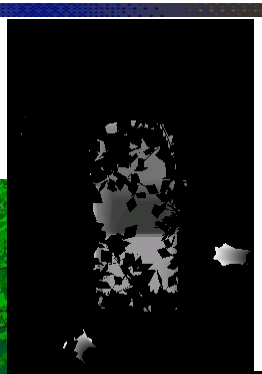
Simulation data



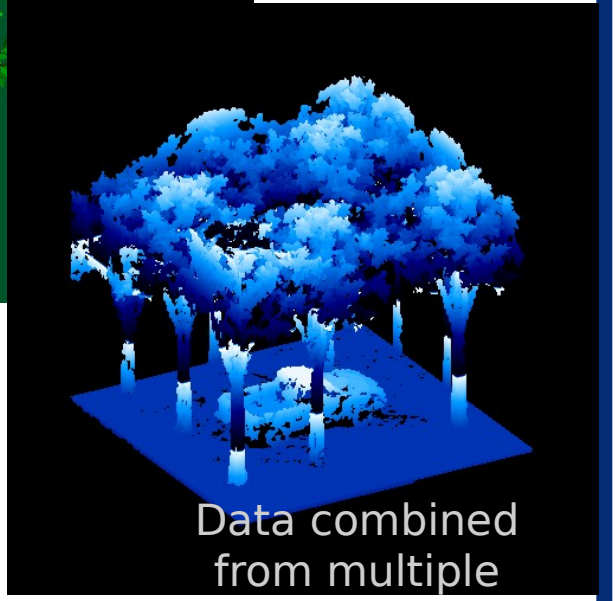
LADAR data collected from multiple locations

EO view from single viewpoint

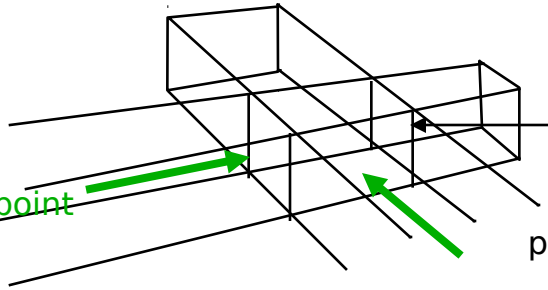




Single view of truck from LADAR through holes in canopy

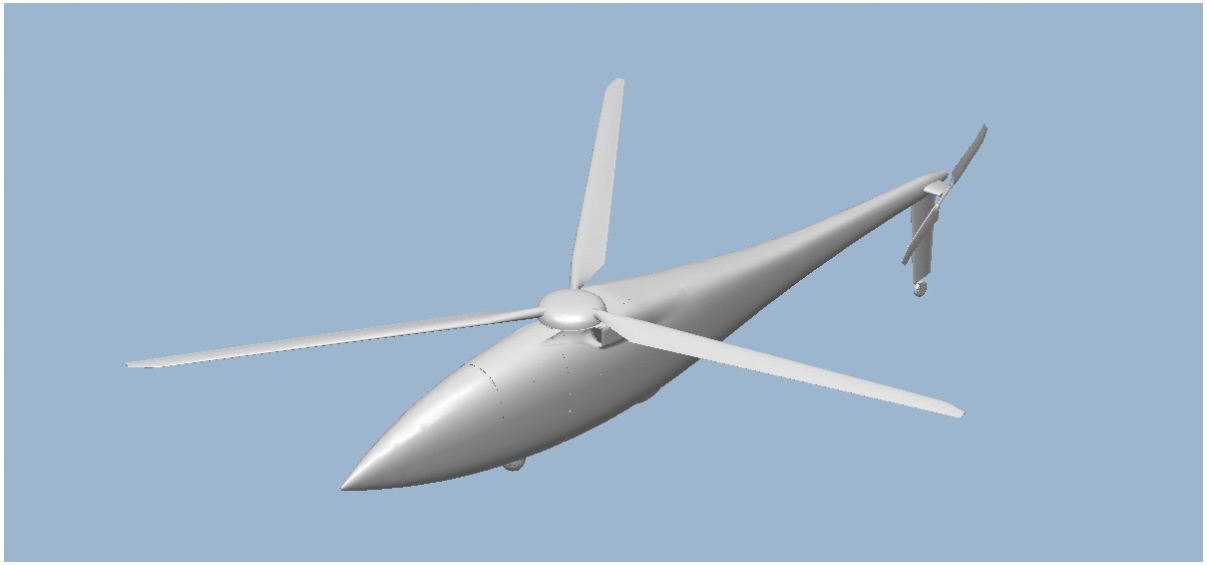


- **Use LADAR data to sense 3-D information:**
  - **To "see through" porous obstructions**
  - **To enable combination from multiple viewpoints**
  - **To enable presentation of data from alternate viewpoints**



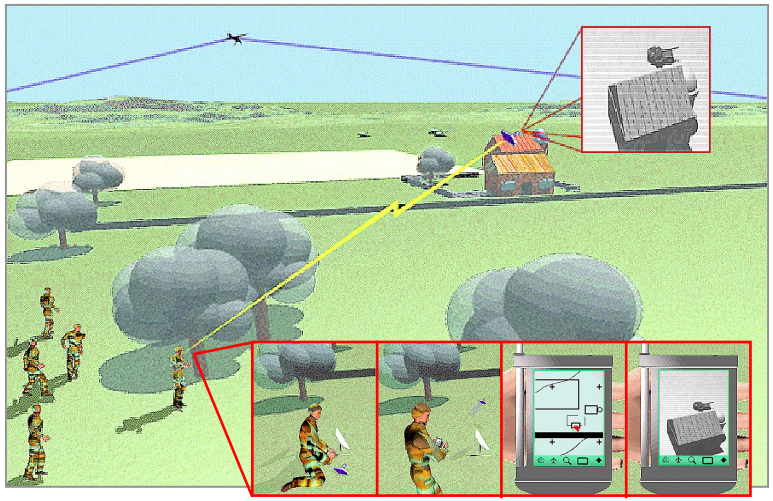
Voxel data from LADAR, combined from multiple viewpoints, presented from a different viewpoint

Hummingbird A160 Vehicle



- **Long Range / Long Endurance VTOL UAV,**
  - 3000+ nm range / 40+ hr endurance
  - 300-500 lb Payload, 4000 lb GTOW
- **Patented Optimum Speed Rotor (OSR) - 50-100% RPM**
- **Rigid In-Plane Rotor - Precision Vehicle Control**
- **High L/D Lightweight Rotor Blades**
- **Affordable**

Organic Air Vehicle



Micro Air Vehicle:

- **Small Air Vehicle about 15 to 45 cm. in any dimension.**
- **Capable of flying in adverse weather at an Affordable Cost.**

Military & Technical Objectives:

- **Enhanced Situational Awareness for FCS Small Units Operations**
- **Enables New Missions in Emerging Warfighting Environments (Urban operations)**
- **Develop and Demonstrate Micro Air Vehicles Capable of Sustained Flight and Useful Military Missions for Future Combat Systems**

FCS Robotics Programs

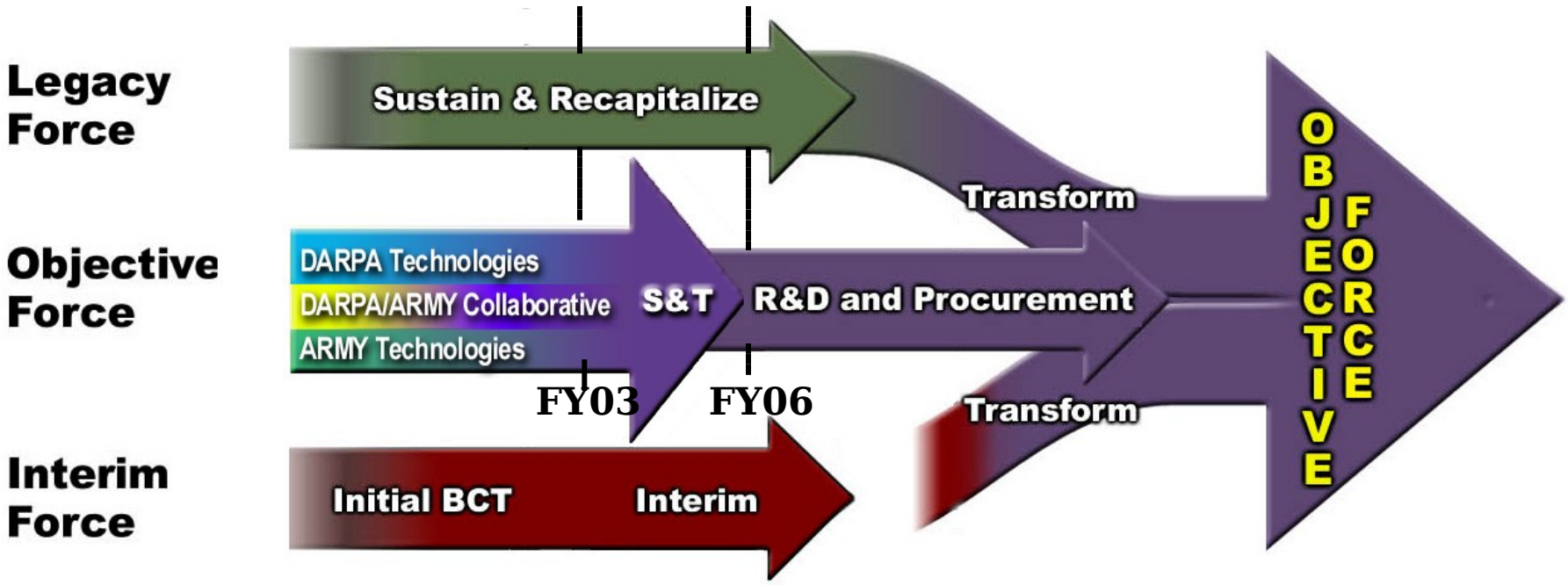
Unmanned Ground Combat Vehicle (UGCV)

- Exploit lack of a human crew in robot designs to:
  - Increase autonomous mobility by negotiating larger obstacles
  - Enhance utility by pushing the simultaneous boundaries of payload fraction, endurance, signature

Autonomous Navigation: PerceptOR

- Increase off-road autonomous mobility by advanced perception algorithms and

The Army Transformation



. . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable.

What is the FCS Program?

- ***A collaborative program between DARPA and the US Army to evaluate and competitively demonstrate Future Combat Systems***
- **The FCS Program will:**
  - **Define and validate FCS design/operational concepts using modeling and simulation and surrogate exercises**
  - **Develop key enabling technologies for distributed lighter forces**
  - **Fabricate and test a multi-mission FCS Demonstrator to facilitate EMD and production**

Simultaneously conduct a system/concept definition and design addressing the enabling technologies, allowing a critical decision in FY 03 and the creation of a systems demonstrator by FY 06

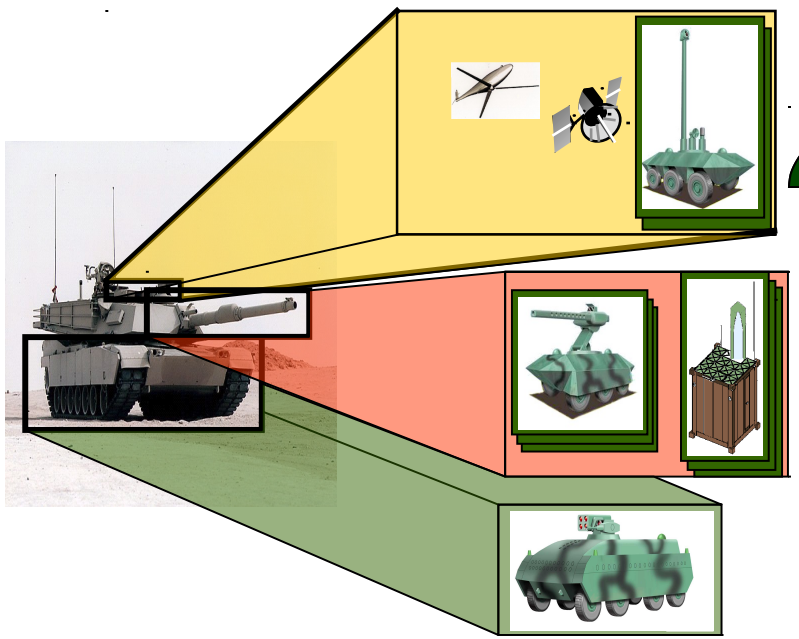
Why DARPA?

- **DARPA's role in DoD is to be the technical enabler for innovation for national security**
- **DARPA serves as a temporary independent agent to catalyze radical innovation for the Army**
- **FCS must go back to the Army for full development**

The Challenge

- **What makes the DARPA/Army Collaborative Demonstration Program so challenging?**
  - **Short-term, parallel development of system-of- systems concepts and key technology efforts**
  - **New operating concepts are being developed concurrently**
  - **System concept incorporates network warfare and relies heavily on robotics**

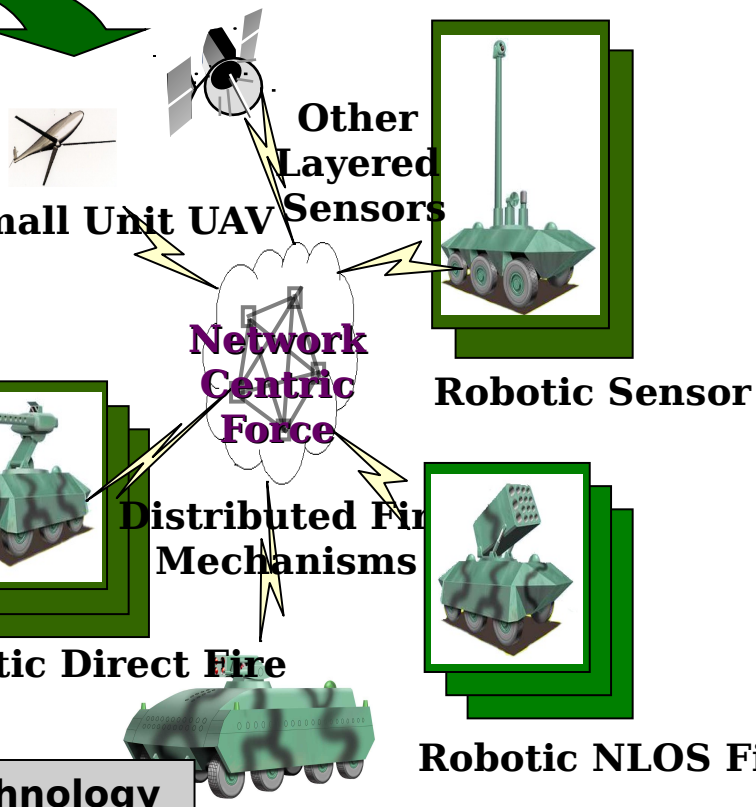
Baseline System Concept



From This...

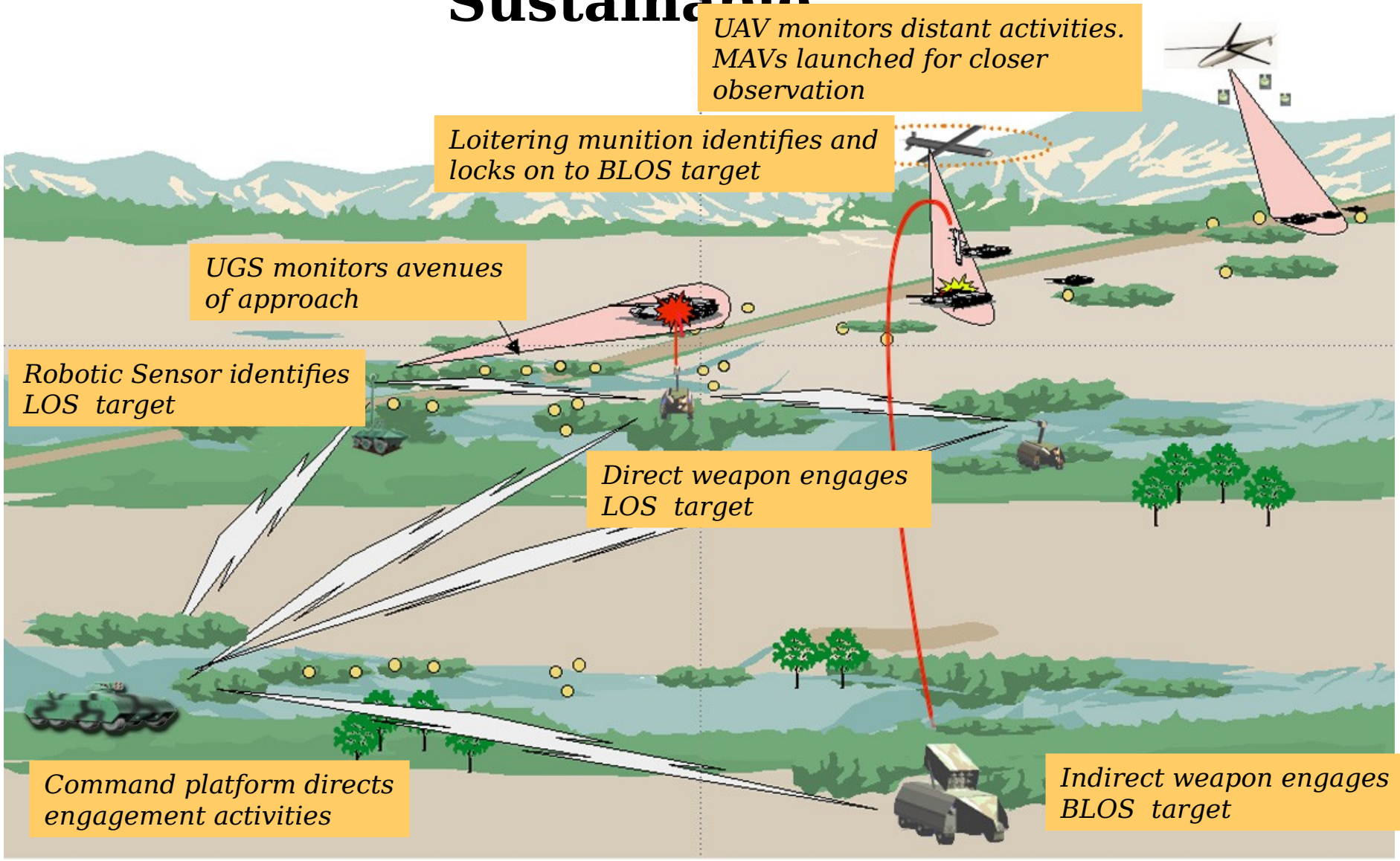
Network Centric Distributed Platforms

To This...



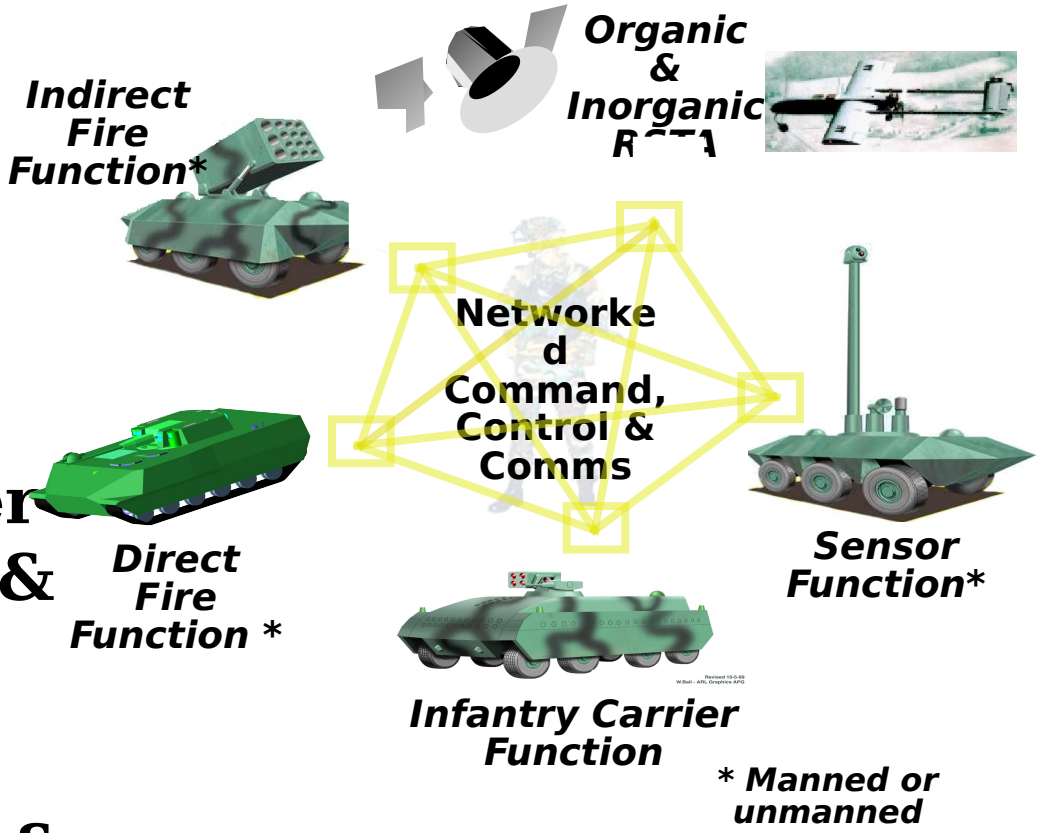
Exploit Battlefield Non-Linearities using Technology to Reduce the Size of Platforms and the Force

FCS . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable


UAV monitors distant activities. MAVs launched for closer observation
Loitering munition identifies and locks on to BLOS target
UGS monitors avenues of approach
Robotic Sensor identifies LOS target
Direct weapon engages LOS target
Command platform directs engagement activities
Indirect weapon engages BLOS target

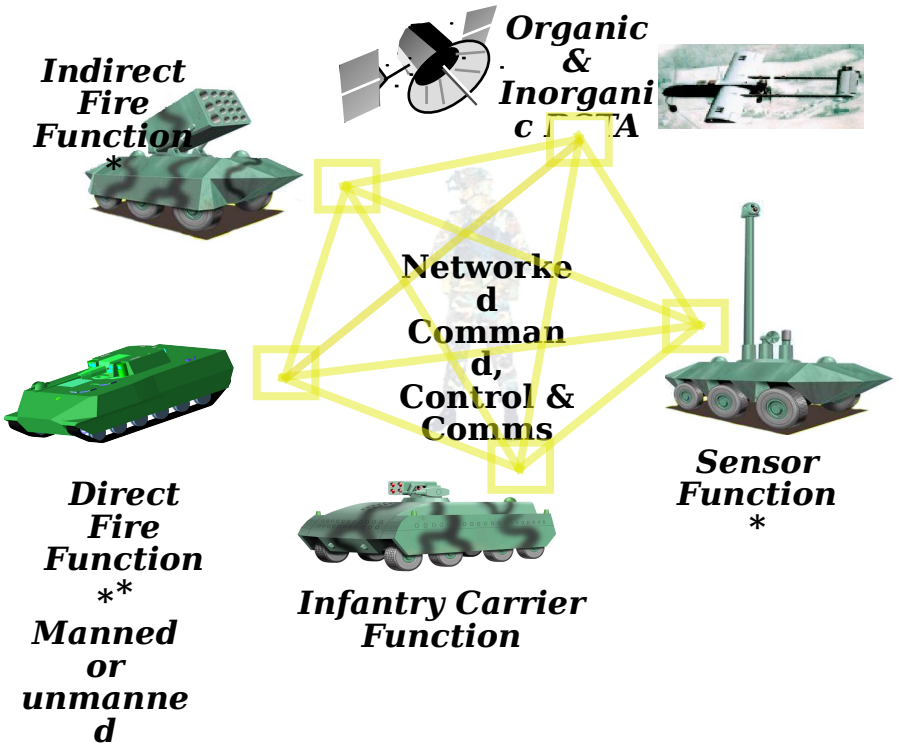
Major Technology Challenges

- **Autonomous Unmanned Ground Vehicles**
- **Maneuver BLOS**
  - **Networked Fires**
- **Organic All-Weather Targeting Vehicles & Sensors**
- **Networked Command, Control & Communications**



What Makes FCS Different?

- **Network centric**
  - **Know precisely, in real-time, location of all friendly and enemy forces**
- **Robotics integrated into force**
  - **Amplify capability of manned elements**
  - **Multi-functional (RSTA, armed, sustainment)**
- **Increased reliance on extended range engagement**
  - **Organic plus strategic and tactical support**
  - **Long range ISR and precision fires**
- **Capable of air-mobile operations**
  - **Commercial and minimum DoD strategic and tactical lift**



FCS Command and Control

Develop an integrated C² architecture that interfaces with the Army Battle Command System

- **Ensures interoperability with legacy forces**
- **Reduces command personnel by the breaking of functional stovepipes**
- **Add organic sensor and indirect fire control functions**
- **Wait for *component* C² to be defined within technology programs**
  - Integrated Concept Development combined with system architecture as concept matures

Conduct experiments to validate concept

Pursue technology opportunities as they

FCS Communications

Technical Challenges:

- **High Data Rates**
  - **Low latency, real-time traffic**
- **Low Probability of Detection**
  - **Sensor to decision maker**
- **Anti-Jamming**
  - **Decision maker to shooter**
- **Mobile Ad Hoc Networking**
  - **Seamless multi-band operation**
  - **Dynamic, sporadic, combs-on-the-move**
- **RF Information Assurance**
  - **Network layer and below**

FCS Management

- **LTC Marion Van Fosson, US Army, is DARPA Program Manager for system-of-systems work**
- **Dr. Allen Adler of DARPA is Chief Scientist for Enabling Technologies**
- **Individual DARPA Program Managers are managing Enabling Technologies work**
- **Total program dollars:**
  - **Through FY 03: $614.2M**
  - **FY 04 - FY 05: $302.0M**

Transformation of land warfare is critical for future National Security

DARPA is supporting this transformation

By conducting critical technology risk reduction efforts

combined with

Iterative experiments emphasizing the interplay between technology and new